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(54) **STAGED LOCK FEATURE FOR AN ELECTRICAL CONNECTOR ASSEMBLY HAVING A CAM MATING DEVICE**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 10/159,174, filed on May 31, 2002, which is a continuation-in-part of application No. 09/795,692, filed on Feb. 27, 2001, now Pat. No. 6,422,881.

(51) **Int. Cl.**[7] **H01R 13/62**
(52) **U.S. Cl.** **439/157**
(58) **Field of Search** 439/157, 372, 439/159

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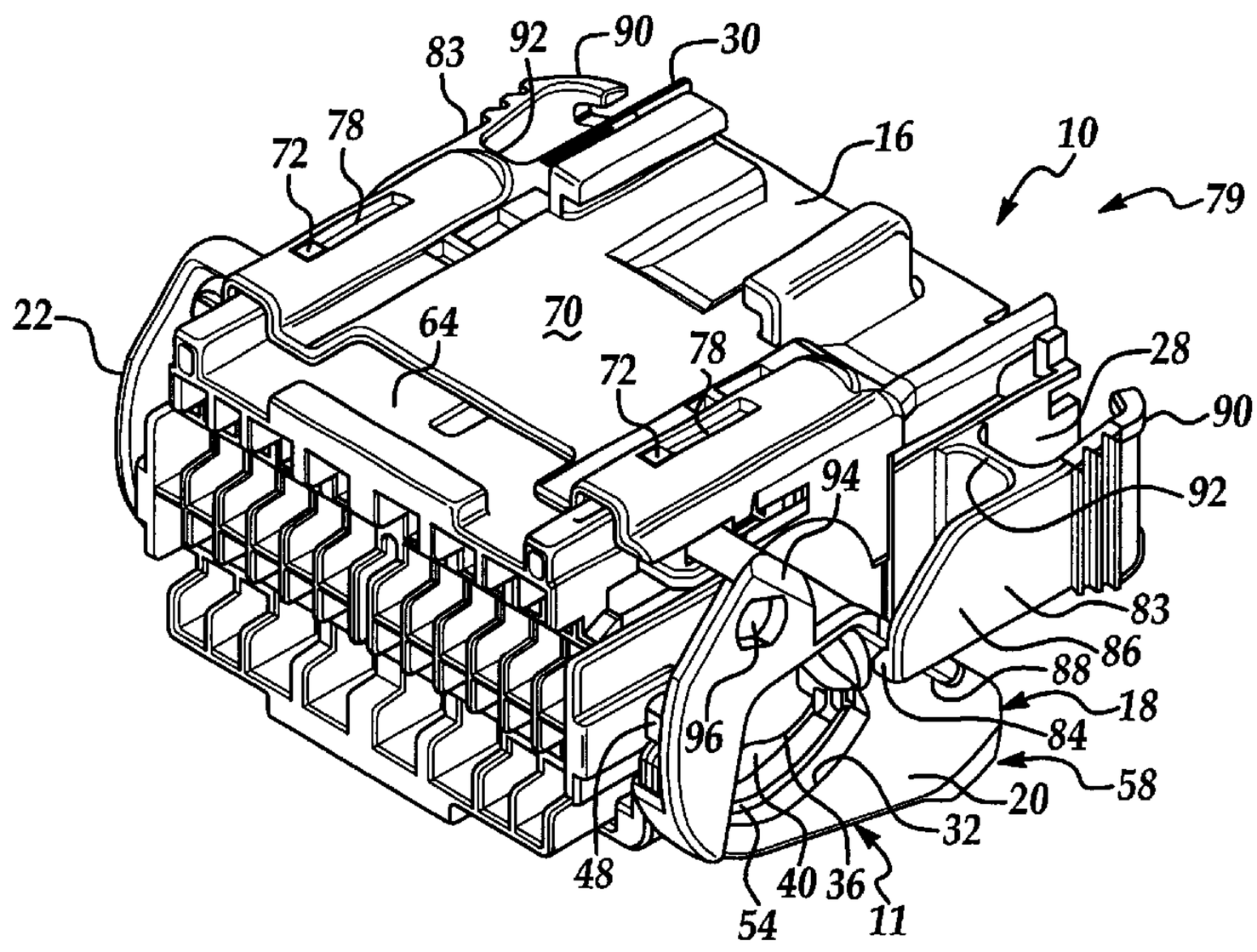
(57) **ABSTRACT**

An electrical connector assembly has a first connector with preferably two oppositely protruding cam followers and a second connector having a pivoting cam lever having preferably two lever arms. The two lever arms respectively engage the earn followers when the first connector is initially staged and locked partially into a cavity defined by the second connector, and as the cam lever pivots from an open position and towards a mated position. The first connector, once locked in the staged position within the forward cavity of the second connector, can not be easily or inadvertently withdrawn, thus, proper orientation of the cam followers to the cam lever is assured for initial cam engagement. The assembly is locked in the staged position by the snap fitting of a tab, which projects laterally from the first connector, into a close ended groove carried by a flex wall which is cantilevered from the second connector. Should the first connector be inadvertently pulled backward from the mating direction, a forward facing stop surface of the tab engages, and thereby prevents further withdrawal of the first connector, with a rearward facing lock seat of the flex wall. The stop surface of the tab is disposed substantially perpendicular to the mating direction preventing inadvertent flexing of the flex wall which would otherwise un-lock the first connector from the staged position.

12 Claims, 3 Drawing Sheets



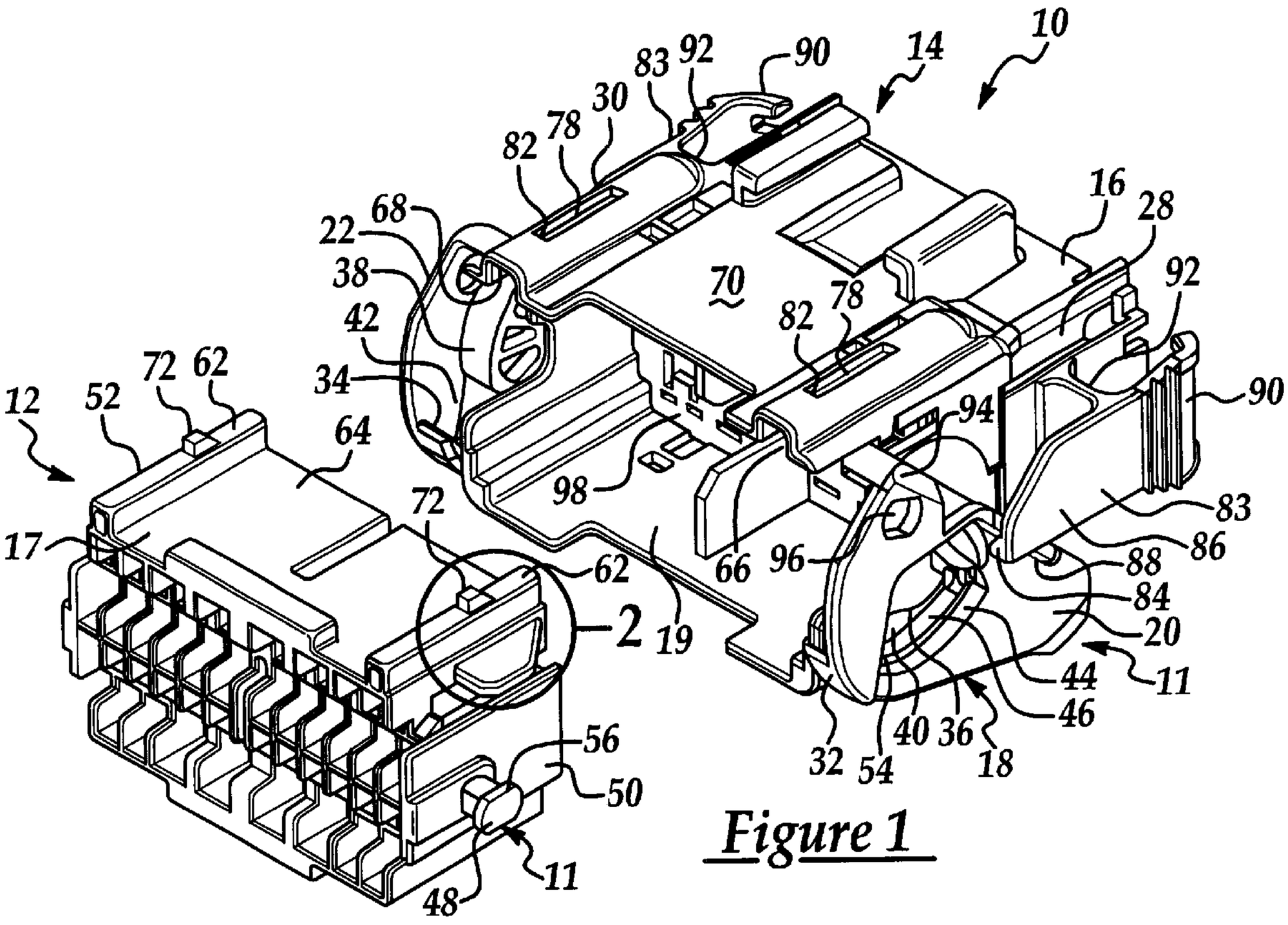


Figure 1

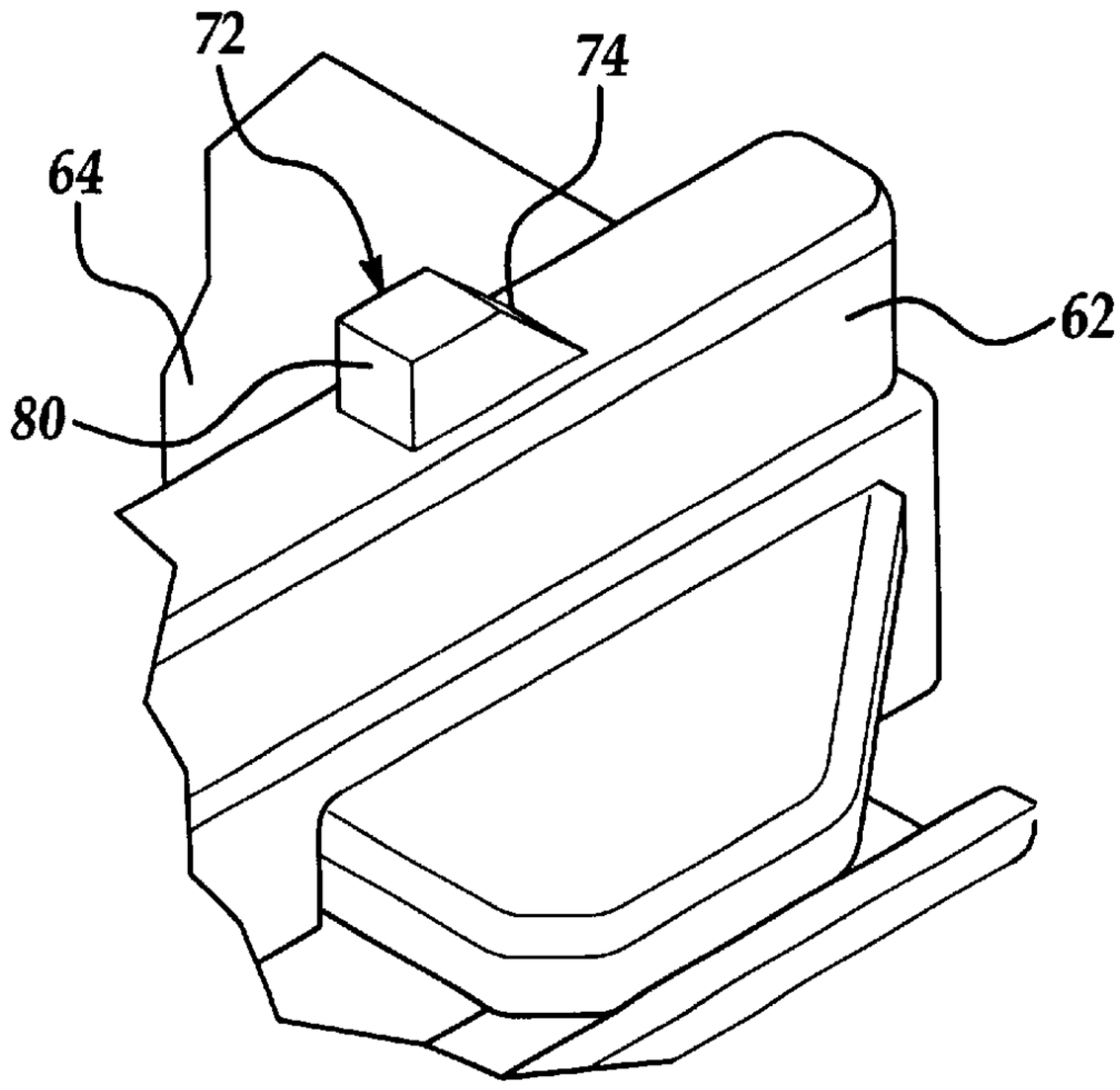


Figure 2

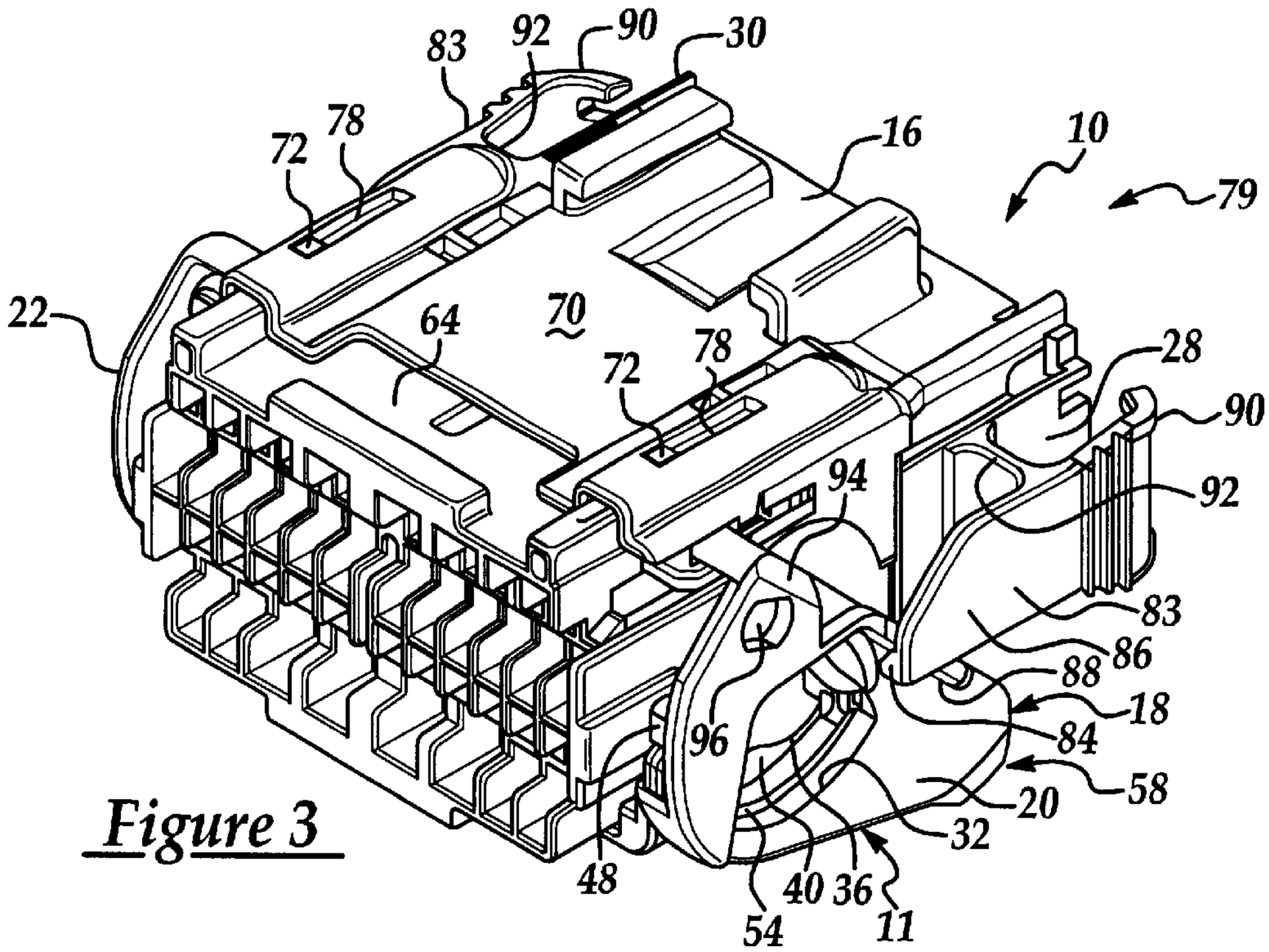


Figure 3

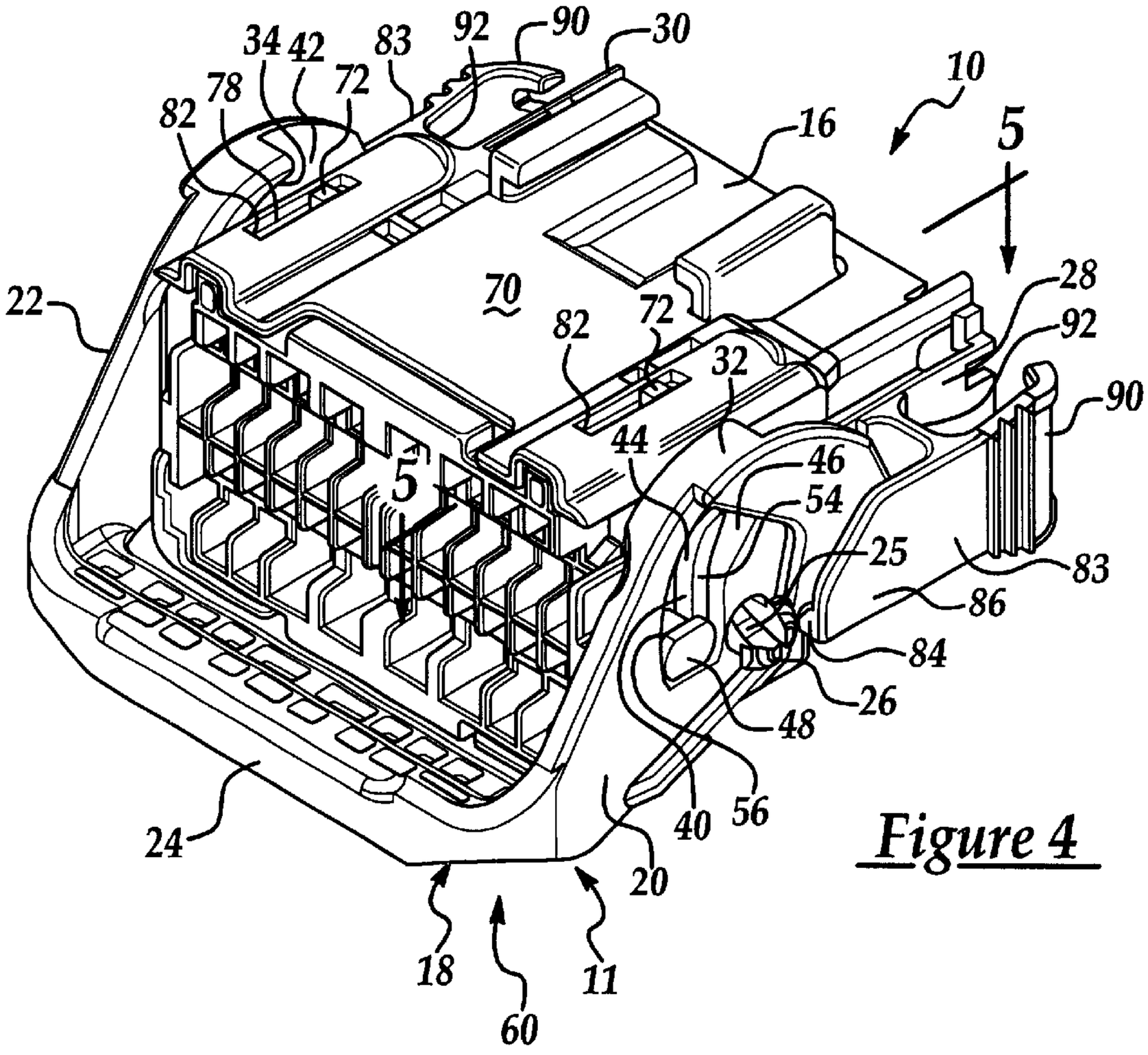


Figure 4

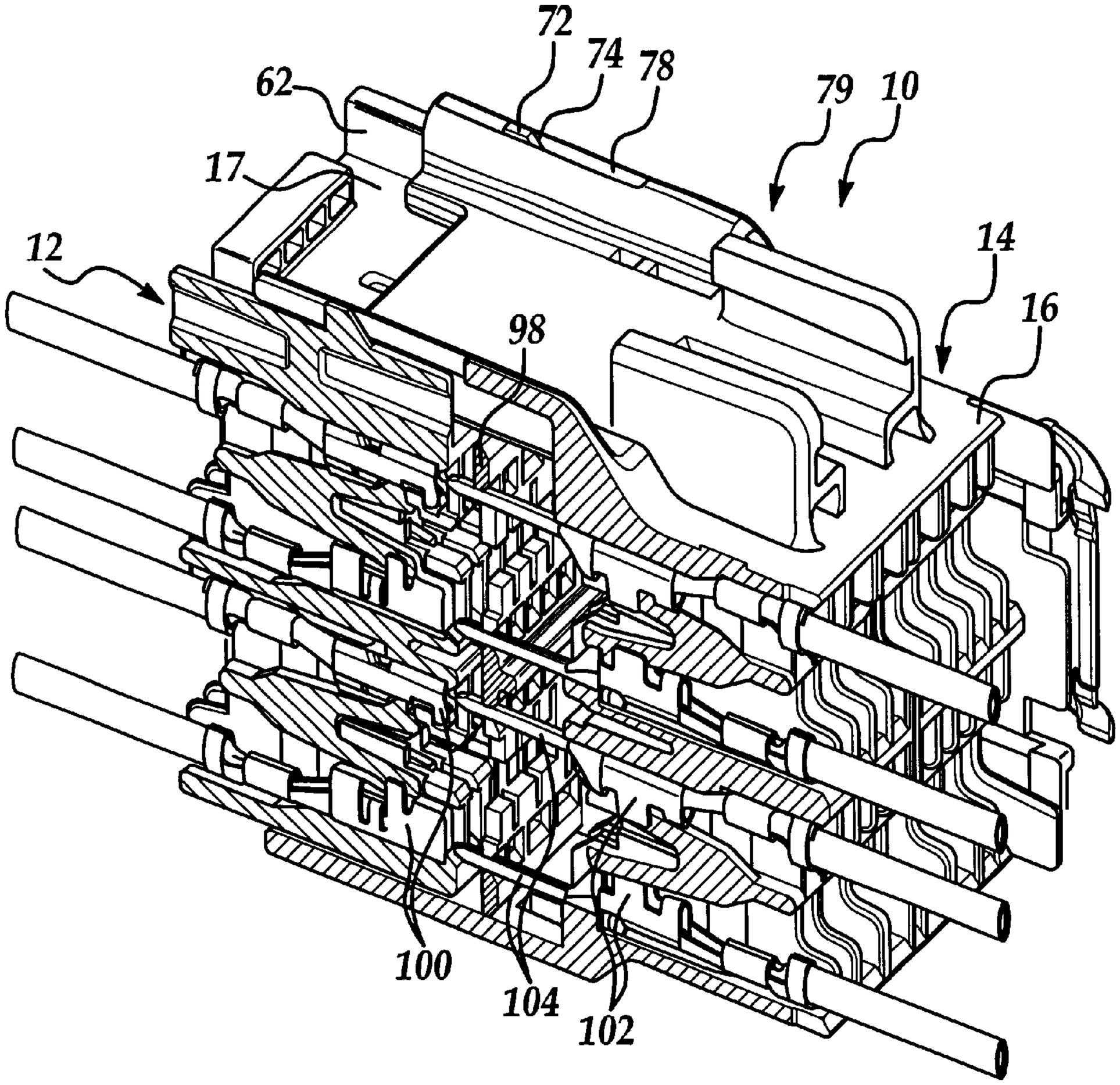


Figure 5

STAGED LOCK FEATURE FOR AN ELECTRICAL CONNECTOR ASSEMBLY HAVING A CAM MATING DEVICE

RELATED PATENT APPLICATION

This is a continuation-in-part application of U.S. patent application Ser. No. 10/159,174, filed May 31, 2002, which is a continuation-in-part of U.S. U.S. Ser. No. 09/795,692, filed Feb. 27, 2001 (U.S. Pat. No. 6,422,881, issued Jul. 23, 2002).

TECHNICAL FIELD

The present invention relates to a staged lock feature for an electrical connector assembly and more particularly to a staged lock feature for an electrical connector assembly having a cam mating device.

BACKGROUND OF THE INVENTION

Known electrical connector systems such as those used with automotive vehicle electrical harnesses typically comprise plastic housings for male and female connectors that fasten together to secure coupling of terminals mounted within the housings. Many male and female connector pairs require a high amount of force to completely engage, resulting in large exertion by the person assembling the connectors together.

To reduce the amount of effort required to assemble connectors while achieving reliable electrical continuity some connectors are provided with cam mating devices. Cam mating devices typically include one or more cam surfaces on an operator handle or lever that is mounted to the housing of one of the connectors to be mated. The other connector housing has one or more protruding cam followers to engage the cam surface(s) so that, as the lever or handle is moved in the desired direction, the cam surface(s) act on the cam follower(s), drawing the connector housings together and forcing secure engagement of the connectors.

One type of cam mating device is a cam lever that transfers rotary motion of the cam lever into linear movement between the connector and a mating connector, facilitating secure engagement of the two connectors and reducing the amount of operator exertion required when making the secure engagement. To operate, the connector having the cam follower must be "staged" or partially inserted into the mating connector to properly orient the cam follower to the cam lever for initial cam engagement. Unfortunately, if the cam follower is not properly aligned to the cam lever, operation of the cam locking feature can result in inadvertent damage to the cam lever or may result in a poorly mated electrical connector assembly.

SUMMARY OF THE INVENTION

An electrical connector assembly has a first connector with preferably two oppositely protruding cam followers and a second connector has a pivoting cam lever having preferably two lever arms. The two lever arms respectively engage the cam followers when the first connector is initially staged and locked partially into a cavity defined by the second connector, and while the cam lever pivots from an open position and towards a mated position. The first connector once locked in the staged position within a forward cavity of the second connector can not be easily or inadvertently withdrawn. Thus, proper orientation of the cam followers to the cam lever is assured for initial cam engagement.

The connectors are locked in staged position by a tab which projects laterally from the first connector and a flex wall which is cantilevered from the second connector and extends forward and parallel to a mating direction of the assembly. During placement of the first connector into the staged position, a preferably ramped rearward facing surface of the tab engages a distal edge of the flex wall causing the flex wall to resiliently flex laterally outward until the tab snaps into a close ended elongated groove which extends along the mating direction. Withdrawal of the first connector from the second connector when in the staged position is prevented via engagement of a forward facing stop surface of the tab with a lock seat of the flex wall which defines the forward closed end of the groove. The stop surface of the tab is disposed substantially perpendicular to the mating direction. Therefore, any inadvertent force placed upon the connectors in a direction opposite to the mating direction will not have a tendency to flex the flex wall laterally outward which would then unwantedly release the flex wall from the tab and thus release the first connector from the staged position.

Advantages of the present invention include a cam lever engaging electrical connector assembly having a locked or non-releasing staged position for reliable engagement of the cam locking or mating feature. Yet other advantages of the present invention are the relatively simple and inexpensive design of the locked staged position feature and its easy incorporation into existing connector assembly designs to reduce the opportunity of cam lever damage during the connector mating process.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, advantages, and features of the present invention will be apparent to those skilled in the vehicle arts upon reading the following description with reference to the accompanying drawings, in which:

FIG. **1** is an exploded perspective view of an electrical connector assembly in accordance with the present invention;

FIG. **2** is an enlarged perspective view of a tab taken from the circle labeled **2** in FIG. **1**;

FIG. **3** is a perspective view of the electrical connector assembly shown in a staged position with a cam lever of a cam mating device shown in an open position;

FIG. **4** is a perspective view of the electrical connector assembly shown with the cam lever in a mated position; and

FIG. **5** is a cross section of the electrical connector assembly shown with mating terminals not yet in electrical contact while the assembly is in the staged position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIG. **1** illustrates mating connector assembly **10** utilizing a cam mating device **11**. Connectors **12, 14** of the assembly **10** are shown without the terminals or harness wires to avoid cluttering but it will be understood by those skilled in the art that terminals of a known type for terminating harness wires are implemented in the connectors **12, 14** in a known manner. The connector **14** comprises housing **16** and cam lever **18** pivotably mounted thereon. The connector **12** moves along a linear direction to mate into a leading cavity **19** carried by the housing **16** of connector **14**. The cam lever **18**, the housing **16** of connector **14** and the housing **17** of connector **12** are each preferably integrally molded as single plastic parts.

Referring to FIGS. **1**, **3** and **4**, cam lever **18** comprises first and second arms **20**, **22** (see FIG. **4**) connected at their ends by a handle portion **24**, as best shown in FIG. **4**. The cam lever **18** includes on each arm **20**, **22** a radial surface **25** which defines a circular opening (only one shown) and operates as a bearing surface, riding on a circular cylindrical protrusion **26** (only one shown), one of which extends from a side **28** of the housing **16** and the other of which extends from a side **30** of the housing. The cavity **19** is defined laterally between the two sides **28**, **30**. Each arm **20**, **22** has a lower or outer cam wall **32**, **34**, respectively, that follows substantially a partial revolution of a spiral, gradually decreasing in radius from opposite the front portions of inner cam walls **36**, **38** defining cam pathways **40**, **42** which emerge as trailing slots through each respective arm **20**, **22**.

Referring to FIG. **4**, within slot or pathway **40**, the inner cam wall **36** deviates into an interior and exterior slot wall **44**, **46**. Similarly, partially through the cam pathway **42** which leads into the slot **40**, the inner wall **36** divides into an interior and an exterior slot wall (not shown). The interior slot walls **44** define the cam pathways **40**, **42** for respective cam followers **48** which project from respective first side **50** and opposite second side **52** of connector **12**. Vertical walls **54** spanning between the interior slot walls **44** and the exterior or recessed walls **46** form sliding surfaces for the radially projecting end caps or shoulders **56** of the cam followers **48** locking the cam followers **48** within the respective pathways **40**, **42**, when the cam lever **18** is moved from an open position **58** shown in FIG. **3**, to a mated position **60** shown in FIG. **4**.

In operation, and prior to moving the lever **18** from the open position **58** to the mated position **60**, the housing **17** of connector **12** is first inserted into the cavity **19** of housing **16** of connector **14**. During insertion, two longitudinally extending ribs or keys **62** projecting upward from a top surface **64** of the connector **12** slide snugly into and along respective receiving channels **66**, **68** carried by a top flex wall **70** which extends laterally between the two sides **28**, **30** and in-part defines cavity **19** of the connector **14**.

Referring to FIGS. **1** and **2**, a locking tab **72** projects upward from an approximate mid-point of each key **62**. The locking tab **72** has a leading ramped surface **74** which engages a leading edge of the top flex wall **70** carried at the inverted bottom of the respective channels **66**, **68**. This engagement, with continued insertion of the connector **12** causes the top flex wall **70** to flex upward permitting ingress of the tabs **72** into the channels **66**, **68**. Insertion is continued until the tabs **72** snap lock into the forward ends of longitudinally extending close-ended slots or grooves **78**, as best shown in FIG. **3**.

Each side **28**, **30** of housing **16** has leading open ended windows **76** orientated near the top flex wall **70** and channels **66**, **68** which cantilevers the top flex wall **70** and thus enable resilient flexing thereof. During insertion of connector **12**, the followers **48** enter and traverse the respective windows **76** as the top of the locking tabs **72**, slide along the inverted bottom of the channels **66**, **68** until the tabs **72** snap lock into the forward ends of the grooves **78**, as best shown in FIG. **3**.

At this point, the connector **12** is in a locked staged state or position **79** to the connector **14** so that withdrawal of the connector **12** from cavity **19** is prevented by engagement of a stop surface **80** of the tabs **72** to a lock seat **82** carried by the top flex wall **70** and defining the forward ends of the through grooves **78**.

The stop surfaces **80** are generally disposed opposite to the ramped surfaces **74** of the tabs **72** and are orientated

substantially perpendicular to the respective keys **62**. Likewise, the lock seats **82** are substantially disposed perpendicular to the longitude of the through grooves **78** and are substantially parallel to the respective stop surfaces **80** so that the top flex wall **70** is not re-urged outward which would then release the tabs **72** from the through grooves **78** and thus the connector **12** released connector **14**. Inadvertent release of the connectors must be prevented, otherwise the followers **48** will become unknowingly misaligned to the cam pathways **40**, **42** causing the connector assembly **10** to mate improperly and/or cause damage to the cam lever **18**.

The cam lever **18** is locked releasably to the housing **16** of the connector assembly **10** via a pair of flex arms **83** when in both the open position **58** and the mated position **60**. When in the open position **58**, a locking protrusion **84** which projects inwardly from a forward end or end portion **86** of each flex arm **83** engages a lock seat **88** carried by a rib and which faces and is orientated near the trailing ends of pathways **40**, **42**. Locking the lever **18** in the open position **58** assures that the lever is aligned properly so that the followers **48** are properly received in the pathways **40**, **42** when the connectors **12**, **14** are in the staged position **79**. To unlock the lever **18** from the open position **58** after the followers **48** are received, ends or end portions **90** of the flex arms **83** are pinched or flexed inwardly toward each other so that the opposite ends **86** carrying the locking protrusions **84** move or pivot outward about flex members **92**, engaged between mid-portions of the flex arms **83** and the respective sides **28**, **30** of housing **16**, and thus clear the lock seats **88**.

The lever **18**, however, should not be released from the open position **58** until the housing **17** of connector **12** is in the locked staged position **79** to the housing **16** of connector **14**, as best shown in FIG. **3**. When in position **79**, the followers **48** are disposed properly in the receiving ends of pathways **40**, **42** so that the lever **18** will then properly operate to mate the connector assembly **10**.

When the cam lever **18** is pivoting from the open position **58** to the mating position **60**, a second protrusion (not shown) orientated parallel to protrusion **84** rides along a beveled edge or tapered surface **94** carried by the respective arms **20**, **22** causing the ends **86** of the flex arms **83** to move outward until the second pair of protrusions snap into lock holes **96** carried by the arms **20**, **22**, at which point the flex arms **83** pivot or snap back to their natural state and the lever **18** is in the mated position **60**.

When the lever achieves the mated position **60** shown in FIG. **4**, the connectors **12**, **14** are fully mated through the action of the cam pathways **40**, **42** on the cam followers **48**. Once in the locked mated position **60** the connector assembly **10** can not be un-mated and returned to the staged position **79** unless the ends **90** of the flex arms **83** are pinched or flexed inwardly toward each other releasing the protrusions **84** from the lock holes **96**. The mated position **60** also acts as a position assurance in that if the cam lever **18** is fully drawn to the position shown in FIG. **4** and locked in place, it can be assumed that the connectors **12**, **14** are fully engaged.

Referring to FIG. **5**, the connector assembly **10** is shown in the staged position **79**. A substantially planar stabilizer **98** is disposed between the connectors **12**, **14** in a pre-staged position. The structure and operation of stabilizer **98** is further detailed in U.S. Pat. No. 6,422,881, incorporated herein by reference. The housing **17** of the connector **12** supports a series of female terminals **100** and the housing **16** of the connector **14** supports a series of male terminals **102** each having a pin or blade **104** projecting through respective

guide apertures **106** of the stabilizer **98**, as best shown in FIG. **1**. When the assembly **10** is in the staged position **79**, the pins **104** are not yet in electrical contact with the female terminals **100** of the connector **14**. When the cam lever **18** is released from the locked open position **58** and begins to move or pivot toward the mated position **60**, the pins **104** of the male terminals **102** will protrude further through the guide apertures **106** of the stabilizer **98** and thus establishes first or initial electrical contact with the female terminals **102**. When the cam lever **18** is in the mated position **60**, the pins **104** are fully inserted and engaged to the female terminals **102**.

Although the preferred embodiment of the present invention has been disclosed, various changes and modifications may be made by one skilled in the art without departing from the scope and spirit of the invention as set forth in the appended claims. It is also understood that the terms used herein are merely descriptive, rather than limiting, and that various changes may be made without departing from the scope and spirit of the invention.

What is claimed is:

1. An electrical connector assembly comprising:

a connector housing having a flex wall, a cavity being open in a forward mating direction and defined in-part by the flex wall, a rearward facing lock seat, and a groove which is carried by the flex wall, communicates laterally with the cavity, is elongated in the mating direction, and is closed at a forward end by the lock seat;

a cam lever engaged pivotally to the connector housing, the cam lever being constructed to pivot between an open position and a mated position;

a mating connector housing having a staged position, a tab having a forward facing stop surface disposed perpendicular to the mating direction, and a protruding cam follower, wherein the mating connector housing is partially disposed within the cavity when in the staged position, the tab is extended into a forward end of the groove when in the staged position so that contact of the stop surface with the lock seat prevents release of the mating connector from the connector housing, and wherein the cam follower is aligned to engage the cam lever when the mating connector is in the staged position; and

wherein rotary movement of the cam lever from the open position to the mated position moves the mating connector from the staged position to fully mate the connector assembly.

2. The electrical connector assembly set forth in claim **1** wherein electrical continuity is not achieved when the mating connector is in the staged position.

3. The electrical connector assembly set forth in claim **2** comprising a stabilizer disposed between the mating connector and the connector housing.

4. The electrical connector assembly set forth in claim **1** wherein withdrawal of the mating connector from the staged position will require appreciable force causing plastic deformation of the tab and the flex wall.

5. The electrical connector assembly set forth in claim **3** wherein mating of the electrical connector assembly is prevented when the mating connector is in the staged position and the cam lever is in the open position via contact of the cam follower with an inner cam wall of the cam lever.

6. The electrical connector assembly set forth in claim **1** wherein the cam lever snap locks to the connector housing when in the open position.

7. The electrical connector assembly set forth in claim **6** wherein the cam lever snap locks to the connector housing when in the mated position.

8. The electrical connector assembly set forth in claim **7** wherein the connector housing has a flex arm having a flex member projecting outward from the connector housing, an end portion cantilevered from the flex member, and at least one locking protrusion projecting transversely from the end portion for snap locking the cam lever in the open and mated positions.

9. The electrical connector assembly set forth in claim **8** wherein the cam lever is disposed between the connector housing and the cantilevered end portion of the flex arm and the locking protrusion projects inward to snap lock to the cam lever.

10. The electrical connector assembly set forth in claim **9** wherein the flex arm has an opposite cantilevered end portion so that manual inward movement of the opposite end portion resiliently flexes the flex member and causes the cantilevered end portion to move outward releasing the protrusion from the cam lever.

11. An electrical connector assembly comprising:

a connector housing having a flex wall, a cavity being open in a forward mating direction and defined in-part by the flex wall, a rearward facing lock seat carried by the flex wall, and a groove being close-ended by the lock seat, wherein the groove is carried by the flex wall, extends in the mating direction and communicates laterally with the cavity;

a mating connector having a staged position, a tab having a forward facing stop surface disposed perpendicular to the mating direction, and a protruding cam follower, wherein the mating connector is partially disposed within the cavity when in the staged position, the tab is extended into a forward end of the groove when in the staged position so that contact of the stop surface with the lock seat prevents release of the mating connector from the connector housing, and wherein the cam followers are aligned to engage a cam lever when the mating connector is in the staged position; and

wherein rotary movement of the cam lever from an open position to a mated position moves the mating connector linearly out of the staged position to filly mate the connector assembly.

12. An electrical connector assembly having a cam mating device, the connector assembly comprising:

a connector housing having a flex wall, a cavity being open in a forward mating direction and defined in-part by the flex wall, a rearward facing lock seat, and a groove being close-ended by the lock seat, wherein the groove is carried by the flex wall, extends in the mating direction and communicates laterally with the cavity; and

a mating connector having a staged position, a tab having a forward facing stop surface disposed perpendicular to the mating direction, wherein the mating connector is partially disposed within the cavity when in the staged position, the tab is extended into a forward end of the groove when in the staged position so that contact of the stop surface with the lock seat prevents release of the mating connector from the connector housing, and wherein the cam mating device is pre-aligned for initiating mating of the connector assembly.

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